

# Characterization of nuclear physics targets using Rutherford backscattering \*

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Many experiments in nuclear physics require targets with a precise characterization. In particular, informations on quantities like the target thickness, the homogeneity, and the amount and kind of impurities are essential [1].

In a recent experiment performed at the 88-Inch Cyclotron of LBNL, we have investigated first chance fission of various polonium isotopes [2]. To do so, we have precisely measured fission excitation functions of the neighboring isotopes  $^{209}\text{Po}$ ,  $^{210}\text{Po}$ ,  $^{211}\text{Po}$ , and  $^{212}\text{Po}$  produced in the reactions  $^3\text{He}$  and  $^4\text{He} + ^{206,207,208}\text{Pb}$ . To study the excitation energy dependence of the first chance fission probability, which is determined by subtracting similar cross sections of two neighboring isotopes, it is essential to measure the cumulative fission cross sections with high precision. While statistical errors can be minimized by measuring a sufficiently large number of fission events, systematic errors, as for example caused by uncertainties in the target thickness, are of particular concern.

We have used a Rutherford backscattering (RBS) spectrometer and particle induced x-ray emission for a precise off-line characterization of targets used in our experiments. Monoenergetic  $^4\text{He}^+$  particles of 1.95 MeV energy generated by a 2.5 MeV van der Graaf accelerator have been utilized. Combining the measured energy and angle of the backscattered particles, the mass and energy of the projectile allows for the identification of the elementary constituents of the sample. The thickness of the sample can be derived from the energy loss, i.e., by determining the energy of the backscattered particles at both edges of the sample.

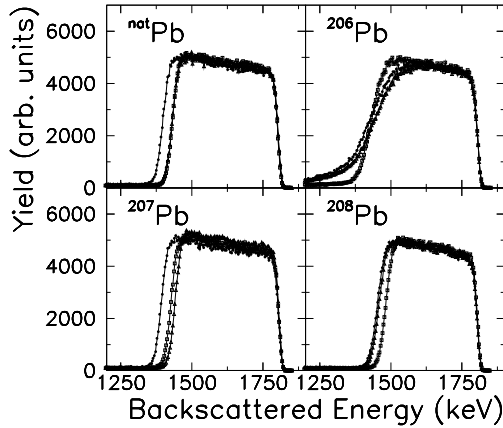


FIG. 1. RBS energy spectra for four lead targets. The different symbols correspond to different positions on the target (center, upper and lower edge).

In Fig. 1, we show the measured energy spectra from

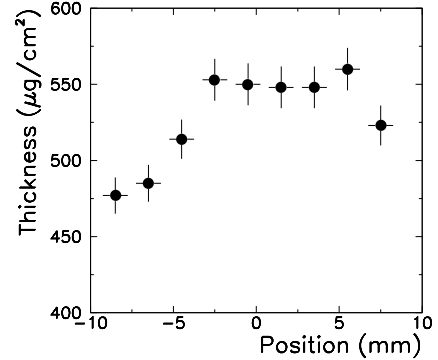


FIG. 2. Target thickness determined by RBS as a function of position on the target surface for  $^{207}\text{Pb}$ .

the RBS analysis for four lead targets. The thickness of the foils are deduced from the widths of the RBS spectra using the energy loss data of the ions in lead. The high energy edge reflects the front and the low energy edge the back of the sample. Small inhomogeneities in the target thickness can clearly be seen in the figure. In general, the spectral edges are sharply defined indicating well defined surfaces. A comparison with the thicknesses determined by direct weighing shows good agreement. In contrast to the RBS method, however, weighing only allows for an average thickness determination.

In Fig. 2, we show the thickness as a function of the distance from the center on the surface of the target. Measurements were made in 2 mm steps to determine the homogeneity. Within the central 8-10 mm, the thickness fluctuation is small. However, the sides are not symmetric. These features have been assigned to the production process. Since the beamspot in our experiment is smaller than 5 mm, the uncertainty in the target thickness is very small.

In order to determine whether any significant target impurities were present, we have furthermore measured particle induced x-ray emission simultaneously during the RBS experiments. This method relies on the spectrometry of characteristic x-rays emitted by the target atoms due to the irradiation with high energy ion beams. Various constituents can be identified via their characteristic x-rays. For the lead targets investigated here, no sizable contribution of contaminations other than a carbon backing, were seen.

[1] , \* Th. Rubehn *et al.*, Nucl. Instr. Meth. A (in print); LBNL-39398; Los Alamos e-print nucl-ex/9609004.

[2] Th. Rubehn *et al.*, this report.